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(54) [Title of the Invention]: Spray Coating Device

(57) Spray coating device, containing a spray device (2) for spraying of coating material on objects being coated, a high-voltage generator (12) to generate high voltage on at least one high-voltage electrode (10) of the spray device (2), a control device (16) to control an electric spray current, which flows with the coating material from the high-voltage electrode to an object being coated, during which the spray current is automatically measured by a spray current measurement circuit (24) and a current rise is counteracted by a voltage reduction, means (18, 20, 22) for current limitation and for high-voltage limitation to a predetermined value, characterized by the fact that the spray current measurement circuit (24) is arranged in the electrical return current path from the object being coated (6) back to the control device (16), in order to measure the spray current there.

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Spray Coating Device

The invention concerns a spray coating device according to the preamble of Claim 1.

A spray coating device of this type is know from EP 0 160 179 B1. An operating person can enter a desired voltage value and a desired current value via a keyboard, which are to be kept constant by a control device. A threshold value is prescribed for the spacing between the spray device and the object being coated. If the spacing is greater than the threshold value, the high voltage on the high-voltage electrode of the spray device is kept constant independently of the object spacing, during which the spray current of the high-voltage electrode becomes smaller with increasing object spacing or larger with diminishing object spacing. If the spacing is less than the threshold value, the spray current is kept constant independently of the spacing changes, a current increase being counteracted by a corresponding voltage reduction. Immediately before the object touches the spray device, the high voltage fully breaks down (contact protection). The spray current from the electrode to the object being coated is directly measured by measuring the electrical current flowing through a primary winding of a transformer, to whose secondary winding a high-voltage cascade circuit, with rectifiers and capacitors, is connected, which generates the high-voltage DC voltage for the electrode.

A spray coating device is known from US 4 000 443, in which a rise in spray current, when an object being coated approaches the spray device, is counteracted by a corresponding reduction of the high voltage, in order to keep the spray current constant. The spray current is indirectly measured by measuring the current flowing in the secondary winding between the transformer and a high-voltage cascade circuit. A spray coating device is known from EP 0 626 208 B1, in which the input voltage of the high-voltage generator is varied inversely to the spray current, in which the spray current is measured indirectly on a electrical resistance connected in front of the high-voltage electrode, in which case a voltage drop is measured. From GB 2 077 006 A, it is known to counteract a current rise of the electrode spray current by a corresponding voltage

reduction of the high voltage within a predetermined operational window. It is known from US 4 187 527 to compare measured spray current measured values with each other at short time intervals and, in the case of a rapid current rise, which indicates a short circuit, to switch off the electrical power supply.

It is known from EP 0 559 608 B1 to measure the electrical spray current flowing from the high voltage electrode to the object being coated with a current measurement device arranged on an electrical current path between the object being coated and ground potential.

Through the invention, the task is to be solved of avoiding the hazard of an unduly high electrical voltage on the high-voltage electrode during large spacing of an electrically conducting object or unduly high current or short circuit current during unduly close approach of an object to the high voltage electrode, during which the object can be an object being coated or an operation person or another object, and to design the spray coating device simultaneously, so that optimal coating results are achieved with the least power expenditure.

This task is solved according to the invention by the combination of the features of Claim 1.

Through the characterizing feature of Claim 1 for direct measurement of the spray current, undistorted measurement results and a rapid reaction of the control device to deviations of the actual values from the reference values are obtained.

Additional features of the invention are contained in the dependent claims.

The invention is particularly advantageous in conjunction with a counterelectrode connected to a potential that has a large electrical voltage difference at the high-voltage potential of the high-voltage electrode, for example, connected to ground potential, in order to divert free electrical particles, especially ions and electrons, that are flowing from the high-voltage electrode, but are acting as free stray currents instead of flying with the spray coating material from the spray device to the object being coated. Counterelectrodes, for example, are known from EP 0 756 899 A2.

The invention is described below with reference to the drawings by means of a preferred variant as example. In the drawings:

Fig. 1 schematically depicts a spray coating device according to the invention ,

Fig. 2 depicts a high-voltage spray current diagram of the spray coating device in Fig. 1,

Fig. 3 schematically depicts a spray device of the spray coating device of Fig. 1.

The spray coating device depicted schematically in Fig. 1 contains a spray device 2 for spraying of coating material 4 in the form of liquid, or preferably powder, onto an object 6 being coated. It is assumed that the objects being coated consist of electrically conducting material and are connected to ground potential 8. The objects 6 are transported in automatic installations through a feed device (not shown) to the spray device and extend into the spray jet of the coating materials 4, shown schematically by an arrow.

The spray device 2 is provided with at least one high-voltage electrode 10 for electrostatic charging of the coating material 4, which is supplied by a high-voltage generator 12 with DC high voltage in the range between 1 kV and 150 kV, preferably a value lying in between. The high-voltage generator can contain, in known fashion, a transformer for step-up of a low AC voltage to a higher AC voltage and a cascade circuit, which, in known fashion, contains a number of rectifiers and capacitors and converts the AC voltage to a high DC voltage.

The low AC voltage is generated by an oscillator 14 as a function of a control voltage U-ST, which is a control quantity for the high voltage of high-voltage electrode 10.
The oscillator 14 can be a part of the high-voltage generator 12 and, as such, be integrated in the spray device 2 or, according to Fig. 1, be integrated in the control device that forms a control unit 16.

The control unit 16 contains an operating parameter memory 18, which, via a data transfer path 19 from a data input station, for example, a higher level computer, or manually, for example, via

a keyboard, is variably adjustable, in terms of at least one high-voltage limitation value of HV-BG and at least one spray current limitation value I-BG, which can be entered and stored for the maximum attainable value on the high-voltage electrode. Preferably, several such values for different operating situations, especially for different objects being coated and different spray coating materials can be stored. The stored values can be unchangeable, fixed values in another variant.

The high-voltage limitation value HV-BG is entered from the operating parameter memory 18 in a high-voltage limitation circuit 20. The spray current limitation value I-BG is entered from the operating parameter memory 18 in a spray current controller 22.

The spray current of the high-voltage electrode 10 flowing from an object 6 being coated to ground is measured by a spray current measurement circuit 24 on the side of object 6 connected to ground 8, and entered in the spray current controller as spray current actual value I-S.

The spray current controller 22 compares the spray current actual value I-S with the spray current limitation value I-BG and, as a function of it, generates a high-voltage control quantity U-RG, which is fed from the spray current controller 22 to the high-voltage limitation circuit 20. The spray current controller 22 is preferably a P-I controller (proportional-integral controller).

The high-voltage limitation circuit 20, as a function of the high-voltage value HV-BG and the high-voltage control quantity U-RG, generates the control voltage U-ST, which is fed in the form of a DC input voltage to oscillator 14 and is the control quantity for the high voltage of the high-voltage electrode 10.

The high-voltage limitation circuit 20, for the case in which the high-voltage control quantity U-RG is greater than or equal to the high-voltage limitation value HV-BG, causes the DC value of the control voltage U-ST to equal the high-voltage limitation value HV-BG. In addition, the high-voltage limitation circuit 20, in all cases where the high-voltage control quantity U-RG is smaller than the high-voltage limitation value HV-BG, causes the control voltage U-ST to equal the high-voltage control quantity U-RG. This can be represented as follows:

When	U-RG ≥ HV-BG,
then	U-ST = HV-BG,
otherwise	U-ST = U-RG.

Fig. 2 shows the spray current in μA on the horizontal axis and the corresponding high voltage in kV on the vertical axis. The uppermost characteristic 26, with the solid squares, is a standard characteristic. It shows how, in known devices, the spray current of the high-voltage electrode 10 rises and the high-voltage diminishes simultaneously with diminishing distance between the high-voltage electrode 10 and an object 6 being coated. The high voltage has its maximum value at the greatest possible spacing or infinitely large spacing of the object 6 being coated, or another electrically conducting object from the high-voltage electrode 10.

The middle curve 27 with the unfilled squares concerns a variant, in which the maximum DC high voltage of the high-voltage electrode 10 is limited to a maximum value HV-BG of 80 kV, but no current limitation I-BG was carried out.

The lowermost curve 28, with the black-filled triangles, is obtained with the circuit according to the invention just described, in which both the spray current and the high voltage are limited to a maximum value. It was assumed in Fig. 2 that the high-voltage limitation value HV-BG is 50 kV and the spray current limitation value I-BG is 20 μA (20×10^{-6} A).

The spray device 2 is shown in Fig. 3 with somewhat more detail. It shows that one or more high-voltage electrodes 10 can be arranged outside or inside a coating material channel 30. Coating material, for example, coating powder, is fed to it via a line 31, for example, a tube.

According to Fig. 3, the spray device 2 can be provided with a counterelectrodes 32 (deflection electrode) connected to a reference potential, for example, ground potential, which trap and divert the ground potential free electrical charges (ions, electrons) that are released by electrodes 10. It was found that by means of the invention, far fewer electrical particles are formed, especially free ions, and therefore more limited current loss.

The oscillator 14 in Fig. 3 is connected via an electrical cable 36 to the high-voltage generator 12, which is integrated in the spray device 2, but could also be arranged separate from it, for example, in the control device 16.

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Claims

1. Spray coating device containing a spray device (2) for spraying of coating material on objects being coated, a high-voltage generator (12) to generate high voltage on at least one high-voltage electrode (10) of the spray device (2), a control device (16) to control an electrical spray current, which flows with the coating material from the high-voltage electrode to an object being coated, in which the spray current is automatically measured by a spray current measurement circuit (24) and a current rise is counteracted by a voltage reduction, means (18, 20, 22) for current limitation and high-voltage limitation to a predetermined value,
characterized by the fact
that the spray current measurement circuit (24) is arranged in the electrical return current path from the object (6) being coated back to the control device (16), in order to measure the spray current there.

2. Spray coating device according to Claim 1,
characterized by the fact
that the return current path is connected to ground potential (8).

3. Spray coating device according to Claim 1 or 2,
characterized by the fact
that the current limitation value and/or the high-voltage limitation value are variably adjustable.

4. Spray coating device according to one of the preceding claims,
characterized by the fact
that a memory (18) to store at least one current limitation value (I-BG) and one high-voltage limitation value (HV-BG) is provided, in which the value is variably adjustable.

5. Spray coating device according to one of the preceding claims,
characterized by the fact
that at least one counterelectrode (32), which is connected to a potential sharply deviating from the electrical potential of the high-voltage (10), is provided on the spray device (2) with a spacing from the high-voltage electrode (10) outside of the coating material stream to divert free ions and free electrons, which are generated by the high-voltage electrode (10), but do not fly with the coating material to the object being coated.